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By-Rogler, Paul V.

A Proposal For The Development of Materials Of Instruction For A General Mathematics Curriculum In Grade Nine. Final Report.

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The purpose of this project was the development of a program that would provide for teaching important ideas of general mathematics in a spiral development, that is, a great variety of topics should be included at each level, with each higher level including more advanced stages of the development of each topic. Topics to be considered are fundamental operations with real numbers, mathematical structure, topics in algebra, informal geometry, logic, measurement, probability, statistics, business mathematics, shop mathematics, occupational mathematics, and consumer mathematics. The project staff which consisted of three teachers and a director, produced a program called the Wilmington Operational Mathematics Program that can be used as a basis for the teaching of ninth grade general mathematics. (CH)

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A PROPOSAL FOR THE DEVELOPMENT OF MATERIALS OF INSTRUCTION FOR A GENERAL MATHEMATICS CURRICULUM IN GRADE NINE

Project No. 6-8786
Contract No. OEC-1-7-068786-0351

Author and Project Director: Dr. Paul V. Rogler

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Wilmington Public Schools
P. O. Box 869
Wilmington, Delaware 19899

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The help of Mr. Sol Weiss and Dr. Vincent Haag, who served as consultants on this program, was a big factor in giving solid direction to the project.

The teachers who did the principal writing for the project units are Mr. Arthur Gibson, Mr. Raymond Wilson, and Mrs. Muriel Rains. Their keen interest in general students, and their consistent dedication to the work, made it a profitable venture.

I. Introduction. How best to provide a mathematics program that meets the needs of ninth and tenth grade general mathematics students in Wilmington, Delaware has been the topic of major thinking and planning on the part of high school mathematics teachers in this city for a number of years. Many texts have been used, and each teacher has tried, first, to analyze the needs of his students as he found them, and second, to plan his teaching to fit these needs. This may well be the way of many classes throughout the nation, but our teachers have not been satisfied that their efforts were as successful as they might be with a more suitable program and better materials of instruction.

In 1964 various committees in Wilmington started to develop a program for these two grades that would meet the needs of ninth and tenth grade general mathematics students. They sought to unify the instruction and to provide spiral learning that would develop in a logical way the learning of fundamental operations with whole numbers and fractions, an understanding of per cent, and some informal geometry, as well as some understanding of the structure of mathematics and a liking for mathematics.

A kick-off meeting was held in November, 1964, when Mr. Sol Weiss, professor of mathematics at West Chester State College, Pennsylvania and a former teacher of general mathematics in Philadelphia, helped organize the planning for the improvement of the program. Objectives developed at that and subsequent meetings in the 1964-1965 school year were: 1. Meet needs in today's world. (Practical Applications from Industry and from Consumer Problems); 2. Develop Reasoning Power; 3. Teach arithmetic skills; 4. Adjust to individual needs; 5. Include some structure of mathematics; and 6. Develop enjoyment of mathematics. Also, at these meetings 77% of the faculty agreed to the hypothesis: "Any subject can be taught effectively in some intellectually honest form to any child in any stage of development." Many who agreed added provisions. Here are a few of these:

Must recognize individual differences.
Must have adequate materials.
Need small groups (14-21 students).
Need adequate time.
Eliminate emotionally disturbed children from slow learner classes
Teachers need preparation in methods of instruction with slow learners.

Important recommendations for program development came from meetings in each school (5 schools have ninth grade classes, 4 schools have tenth grade classes). The following Philosophy Statement was accepted in January, 1965:

A PHILOSOPHY FOR TEACHING GENERAL MATHEMATICS IN GRADES NINE THROUGH TWELVE

We believe that students need to see purpose and meaning in their learning experiences.

We believe that teachers of secondary mathematics should accept and consider the heterogeneous makeup of the secondary school population. In order to prepare their students to advance in any future direction that their interests may take them, teachers should seek to discover the needs of their students, to appeal to the interests of their students, and to provide a suitably solid mathematical foundation for their students at every level of mental ability and social development that they find in their classes.

With this general philosophy in mind we have the following objectives for the teaching of general mathematics in grades nine through twelve:

--Provide a program that leads students to understand the needs of today's world and prepare students to meet these needs.

--Provide a sequential program that helps students to develop skills in the fundamentals of mathematics.

--Provide a program that stimulates students to reason logically and to develop mathematical ideas.

--Provide a program that develops in students an appreciation of mathematical structure.

--Provide a program that is flexible enough to adjust to individual needs.

--Provide a program that encourages students to enjoy mathematical experiences.

The General Mathematics Program Committee also agreed to the following overall program statement:

--The consensus was that the program should, in general, be one that provides for teaching important ideas in a spiral development. That is, a great variety of topics should be included at each level, with each higher level including more advanced stages of the development of each topic. Topics to be considered are fundamental operations with real numbers, mathematical structure, topics in algebra, informal geometry, logic, measurement, probability, statistics, business mathematics, shop mathematics, occupational mathematics, and consumer mathematics.

-- The development of topics should be related to real life problems as encountered by people near to the students' age level, wherever possible.

-- Interwoven with the study of any operations or principles should be a developmental explanation of why they operate in the way that they do.

-- Possibly a third track should be developed for students who are in need of remedial help.

By June, 1965, a tentative outline of topics was accepted and a proposal was written to get federal support to provide funds for a writing team to work on this program during the summer. Since the project was not yet approved, the committee continued to operate in the 1965-1966 school year on a part-time basis, and started meeting with representatives of local industry to get their suggestions and to solicit practical problems from them. Some excellent ideas were forthcoming from these meetings.

When the project received federal funding the final writing team was determined and we met with Dr. Vincent Haag, professor of mathematics at Franklin and Marshall College, to plan the work. Only the ninth grade part of our work was included in this project. We had funding for six weeks' work.

Our objectives were:

--To write units of work that incorporate practical applications from the events and affairs of urban life into a general mathematics outline that is modern in its scope.

--To seek out problems from local industry that relate to situations that general students will occupy within a few years after their ninth grade study.

--To write units at a reading level compatible to that of slow learning ninth grade students.

--To incorporate in the units provision for differentiated instruction that helps the teacher challenge each level of student at his own level.

--To keep a developmental treatment of concepts as the heart of the program, with many practical problems used as illustrations.

--To use, very early in the year's work, a topic such as probability to establish in students' minds a feeling that this course is not a repeat of previous work, but a course that provides needed mathematical principles, some new, some old, but all interrelated and taught at a secondary school level.

--To plan the instruction taking into consideration ways in which these students learn. The use of role playing, games, and programmed materials for makeup as well as enrichment, should be written into the program, Real problems that involve student-activity as well as laboratory work should be included.

A basic decision was made to start units with some situation and then to develop aspects of mathematical learning within the situation. We already had a basic outline of the mathematics we wanted to include. We then sought situations that could serve as motivational factors and that could couch the learnings we were seeking to develop.

II. Method. The group of three teachers and the director met Wednesday afternoons and Saturday mornings from January to June, 1967. Dr. Vincent Haag met with us on five Saturday mornings. We also met for four weeks time from June 19 to July 18, 1967. We discussed the many suggestions that had already been made by groups working on the program. We reviewed literature on working with slow learners and perused many reports of other work done in general mathematics around the nation. We called in representatives of local industry and went to visit industrial locations to seek practical problems for use in the program. We interviewed ninth grade students to determine their interests.

We decided on the particular situations that we would include, the mathematics concepts that we wanted to cover, and the sequence of units. Each member of the group then concentrated on a few of the units. For the first unit, Carpentry, we worked together a great deal so that a coordinated development could be ensured. Other units were each developed by one member, with frequent consultations with the whole group. The director coordinated the work by reviewing the aims of each unit with writing team member as the writing was progressing, and by suggesting varied activities for consideration.

Many of the work sheets used are also furnished in transparency form for the teacher for use on an overhead projector. Suggestions for group activities are included throughout the teacher pages.

III. Results. The project produced a program, called the Wilmington Operational Mathematics Program, that can be used as a basis for the teaching of ninth grade General Mathematics. It consists of a set of eleven units of work. With each unit the teacher is provided with sets of student work sheets; a folder containing 35 copies is provided for each student work sheet. Each work sheet is punched with three holes so that it can be kept in a notebook, and each student is provided with a three-hole notebook. The notebook becomes the "text" as the year goes on. The units written are: 1. Carpentry; 2. Math in Sports; 3. Science; 4. World of Work; 5. Practical Nursing; 6. Business Experience and You; 7. Geometry; 8. Sets and Probability; 9. A Modern Factory; 10. Travel; and 11. Algebra is Fun.

The teacher is also provided with a number of teacher sheets that provide suggestions for the teaching of the unit, and with transparencies that illustrate many of the forms used in the program.

IV. Discussion. To initiate the use of the Wilmington Operational Mathematics Program materials, five teachers are being provided with materials for one class, each. They will use the materials as they see fit. The materials are written so that a teacher can give an appropriate work sheet to each student with each lesson. Work sheets provide a variety of tasks and practice work for the students. Completed work sheets are kept in the student notebooks as a "text." The teachers and the director are meeting once a month to exchange suggestions for use and improvement of the materials. Teacher suggestion pages and transparencies are provided with each unit to aid teachers in planning and presenting the work of the unit. Reproduction costs were greater than anticipated and thus funds for purchasing equipment were limited. It is hoped that teachers can obtain suggested teaching equipment items from individual school sources.

The first unit, Carpentry, provides a setting for some basic measurements that helps review the operations of adding whole numbers and fractions. It then introduces a simple scale drawing of a bookcase that requires operations with whole numbers and fractions. Computing costs for the construction of the bookcase provides review of operations with decimal fractions. The discussion of measurement also leads to a review of some elementary principles of informal geometry. This unit should help the teacher to see the mathematics capabilities of his students as they come to him.

The second unit, Math in Sports, uses bowling, football, basketball, and track as motivational background to working with operations in mathematics, to include some graphing and some study of the metric system.

The third unit, Science, provides activities that relate to thinking about the need for standardization of units of measure, and simple formulas of the form $a \cdot b = c \cdot d$. Multiplication and division of fractional numbers is reviewed.

Unit four, World of Work, discusses a visit to the city tax assessment office and some of the problems a clerk might meet. Area problems are neatly introduced and operations with decimal fractions and percents are included.

Unit five, Practical Nursing, considers many mathematical aspects of this occupation in a local hospital. Natural and decimal fractions, percents, metric measure, and chart reading are all woven into the work of this unit.

Unit six, Business Experience and You, takes the student into a local department store. It considers purchases in the store, using actual newspaper ads, and also employee problems such as application forms and Employee's Withholding Exemption Certificate forms. Many percent problems are introduced.

Unit seven, Geometry, considers angles, triangles, and circles, informally, including construction of figures and formulas for area of triangles and circles.

Unit eight, Sets and Probability, presents elementary set theory and elementary probability. It was put in this location, instead of first, as originally planned, to provide a motivational lift for the middle of the school year. After presenting the necessary set ideas, the unit includes a number of experiments that lead students into understanding basic elements of probability.

Unit nine, A Modern Factory, takes the student into the testing department of a local factory. Reading and recording numbers from scales, plus a simple experiment involving a "test" for a good rubber band lead students into computations involving whole numbers, natural and decimal fractions, and percents, as well as some formula substitution work.

Unit ten, Travel, works from the planning of a trip to involve forms for car repair expenses, map reading, gasoline credit cards and trip expenses.

Unit eleven, Algebra is Fun, introduces many concepts of elementary algebra in an informal presentation that develops algebraic principles out of work involving number relations and the basic number properties.

We had hoped to do one more unit, Flow Charts, but it has not been completed. One of the teachers is going to work on it during the year, and it may be added to the program at a later date.

A tape recorder was purchased and some beginnings made in planning how it might be used. An experimental tape was made for use with an addition of fractions work sheet, but it is not included with the report as it needs much further developing. It is not being used in all classes, and is not yet considered to be an integral part of the program. Two of the teachers are planning to continue the experimentation in classes this year. Two uses are contemplated: first, tapes to be used with an eight station listening post as remedial instruction; and second, recorder to tape class discussions for later playback and analysis by students and teacher together.

V. Conclusions. The Wilmington Operational Mathematics Program is a start in organizing a two-year coordinated program for general mathematics students. It provides experimental material that should aid a teacher in providing instruction with built in motivating factors, such as references to current interests of students, use of examples from local industry, presentation of some informal mathematics for its own sake, and use of some learnings that are completely new to the students. Woven into the material is a wealth of practice in working with the fundamental operations with whole numbers, fractions, and percents and some informal geometry.

There is a need for continuing evaluation of the program and, possibly, for writing additional materials to include in this program. This is being done in the 1967-1968 school year by five teachers who are using the materials on an experimental basis.

There is a need to spend time another summer to write the tenth grade materials, as our plan is ultimately to provide a two-year program for ninth and tenth grade general mathematics.

VI. Summary. This project was developed to fulfill a need to plan a program that provides for the education of ninth grade students who may not be planning to enter college. Approximately 65% of the ninth grade students in Wilmington do not plan to attend college. There are many differences among these students yet we find them grouped heterogenously in many ninth grade general mathematics classes.

Accepting the hypothesis that "any subject can be taught effectively in some intellectually honest form to any child in any stage of development," the objectives were to write units of work that incorporate practical applications from the events and affairs of urban life, providing in these units differentiated activities and exercises that would appeal to the interests of the variety of students that we find in ninth grade general mathematics classes.

To accomplish these objectives the director and three teachers, all of whom had extensive experience in teaching ninth grade general mathematics, met for six weeks. They reviewed the recommendations of previous general mathematics curriculum committees in Wilmington; they reviewed many collected references on the subject; they met with a consultant from the college level; they visited local industrial plants and consulted with representatives from these plants; they polled student interests; and they then wrote the units as planned. The result is a set of eleven units that can provide most of a year's work in ninth grade general mathematics. Units that are included are: 1. Carpentry; 2. Math in Sports; 3. Science; 4. World of Work; 5. Practical Nursing; 6. Business Experience and You; 7. Geometry; 8. Sets and Probability; 9. A Modern Factory; 10. Travel; and 11. Algebra is Fun. Each unit includes a number of separate work sheets for student use, provided in packets of 35 for distribution as needed. Materials were provided for five experimental classes and are now in use. Each student is provided with a notebook to hold the work sheets as they are issued for use. Teachers' copies of the program provide many teaching suggestions, and a number of transparencies for use with the units. The five teachers who are using the materials are meeting periodically during the school year to evaluate the units and to rewrite as necessary.

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